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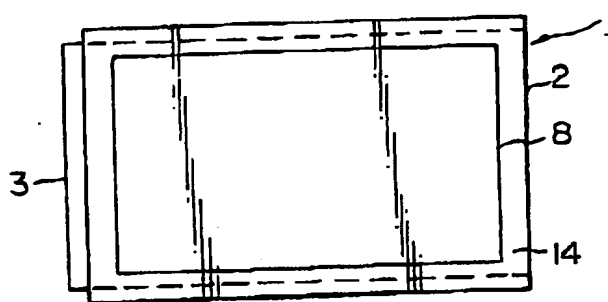
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 UK CL (Edition J) G5C CCA CHB CHC CHE CHG  
 INT CL. G09F, G09G

(54) Liquid crystal display apparatus

(57) In a liquid crystal display apparatus, the background around an effective display range is arranged to have the same colour as the background within the display range for improving the picture quality of characters or pictures formed at or near the edges of the display range. This is done by forming separate electrode patterns around the display range on both the upper and lower substrates of the LCD panel and driving them with suitable voltages so that the voltage difference corresponds to the voltage applied in the display range to produce the colour background. These separate electrodes may be in the form of rectangular frames or of electrodes used similar to those used in the display range. The display apparatus may be used in computers, word processors etc.

Fig. 5



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Fig.1

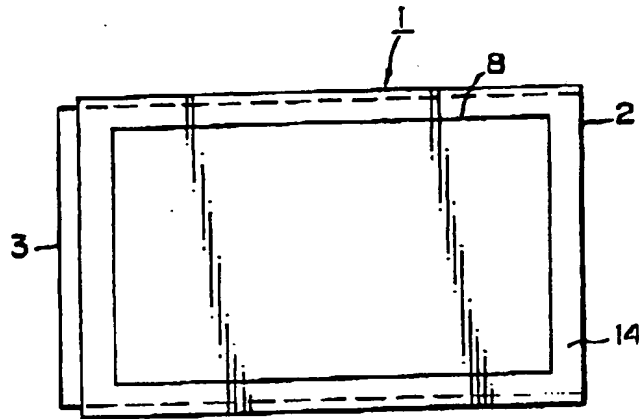
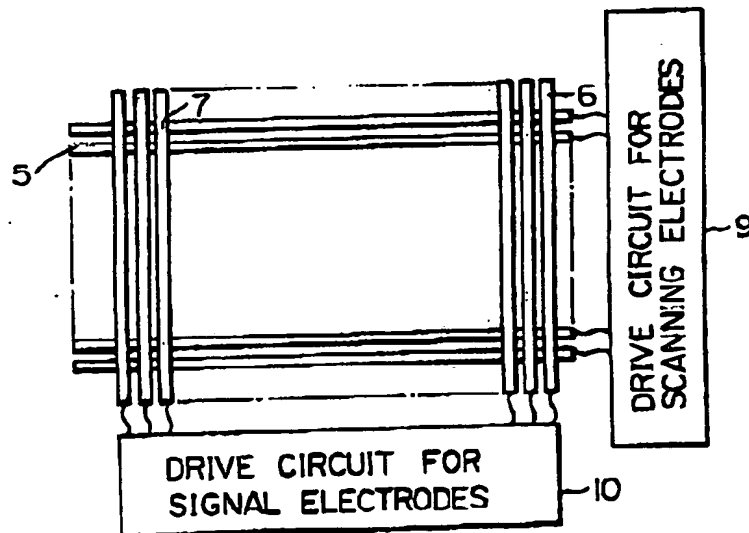


Fig.2



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Fig.3

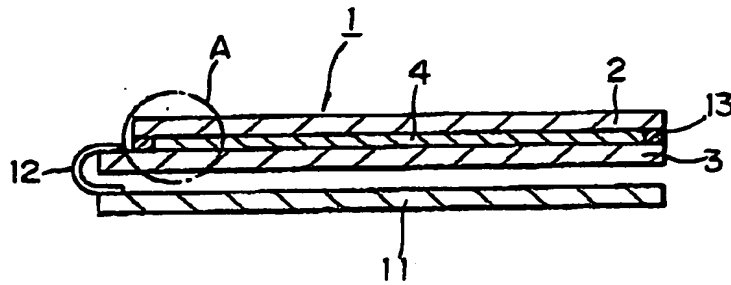
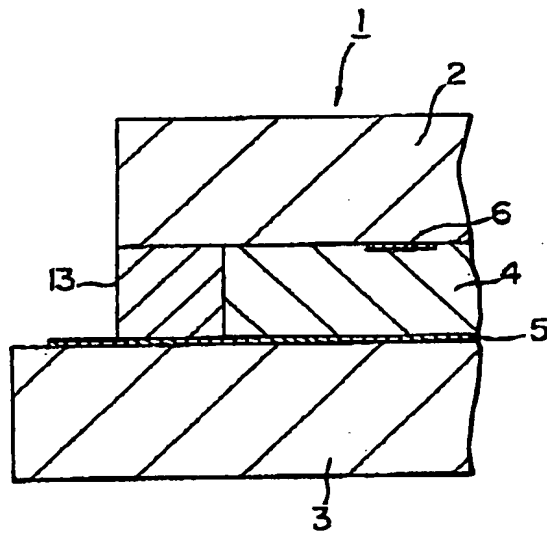


Fig.4



*Fig. 6*

16 5 15 7 15 6 16

17

DRIVE CIRCUIT FOR ELECTRODE PATTERNS

DRIVE CIRCUIT FOR SIGNAL ELECTRODES

10

9

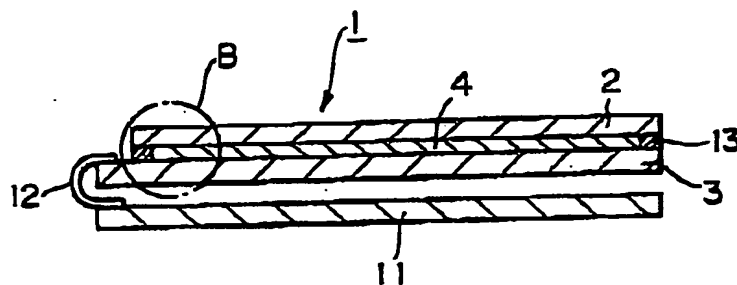
DRIVE CIRCUIT FOR SCANNING ELECTRODES

- 1: LIQUID CRYSTAL DISPLAY
- 2: UPPER GLASS SUBSTRATE
- 3: LOWER GLASS SUBSTRATE
- 4: LIQUID CRYSTAL
- 5: SCANNING ELECTRODES
- 6: SIGNAL ELECTRODES
- 7: DISPLAY PICTURE ELEMENT
- 8: EFFECTIVE DISPLAY RANGE
- 9: DRIVE CIRCUIT FOR SCANNING ELECTRODES
- 10: DRIVE CIRCUIT FOR SIGNAL ELECTRODES
- 11: SUBSTRATE FOR MOUNTING DRIVE CIRCUIT
- 14: OUTSIDE OF EFFECTIVE DISPLAY RANGE
- 15: ELECTRODE PATTERNS
- 17: DRIVE CIRCUIT FOR ELECTRODE PATTERNS

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*Fig. 7*



*Fig. 8*

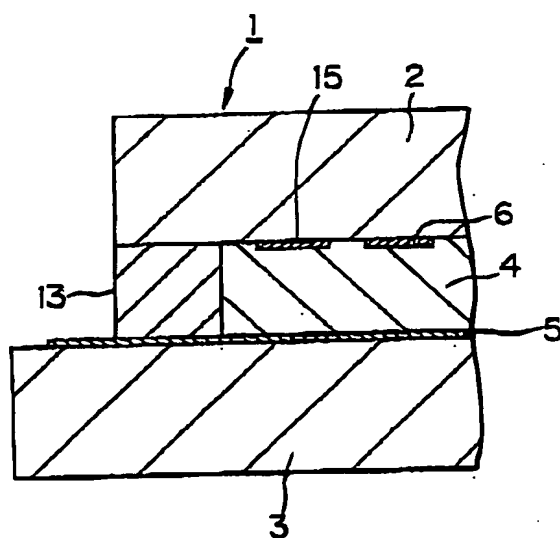
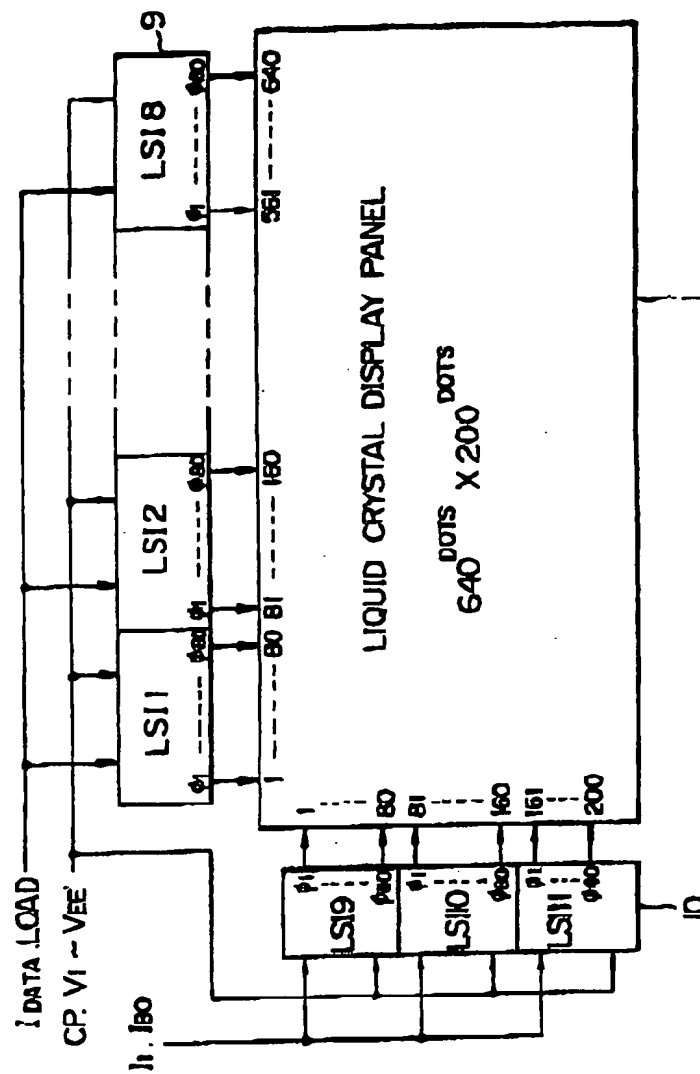


Fig. 9



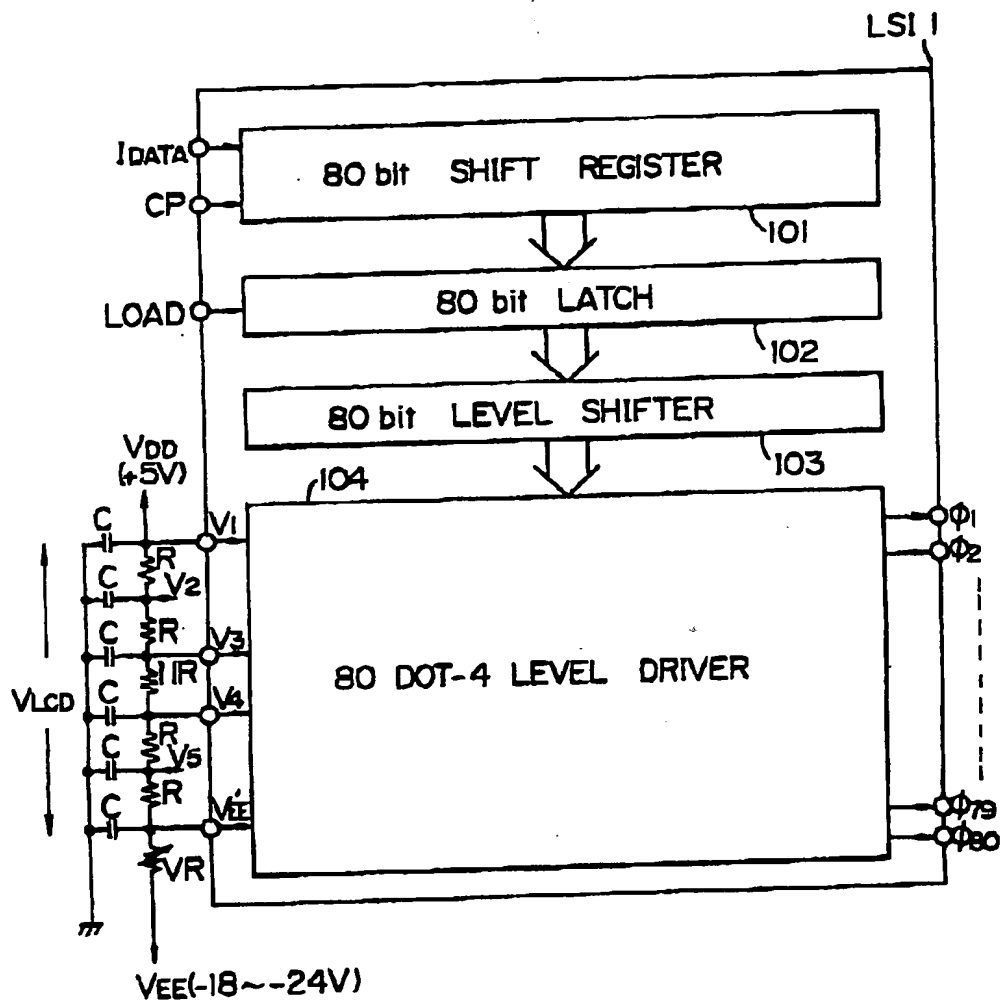
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Fig.10





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Fig. 11A

LOAD

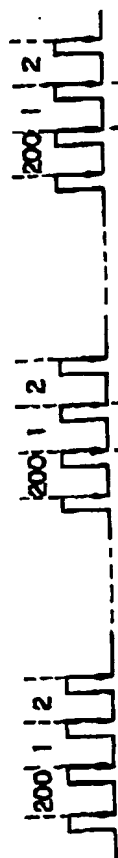


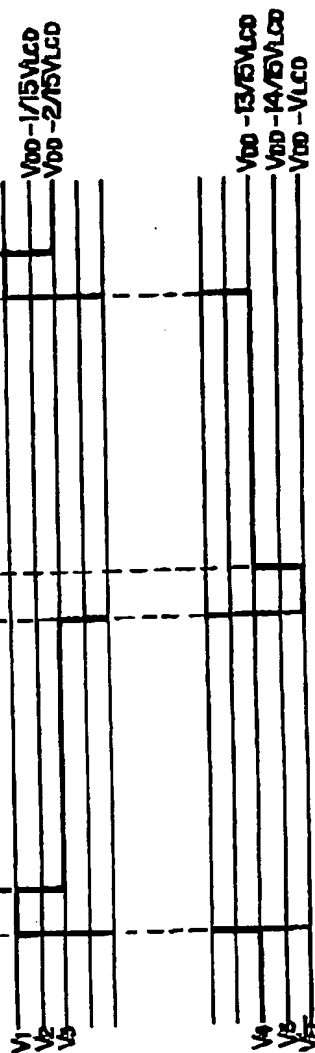
Fig. 11B

LATCH DATA



Fig. 11C

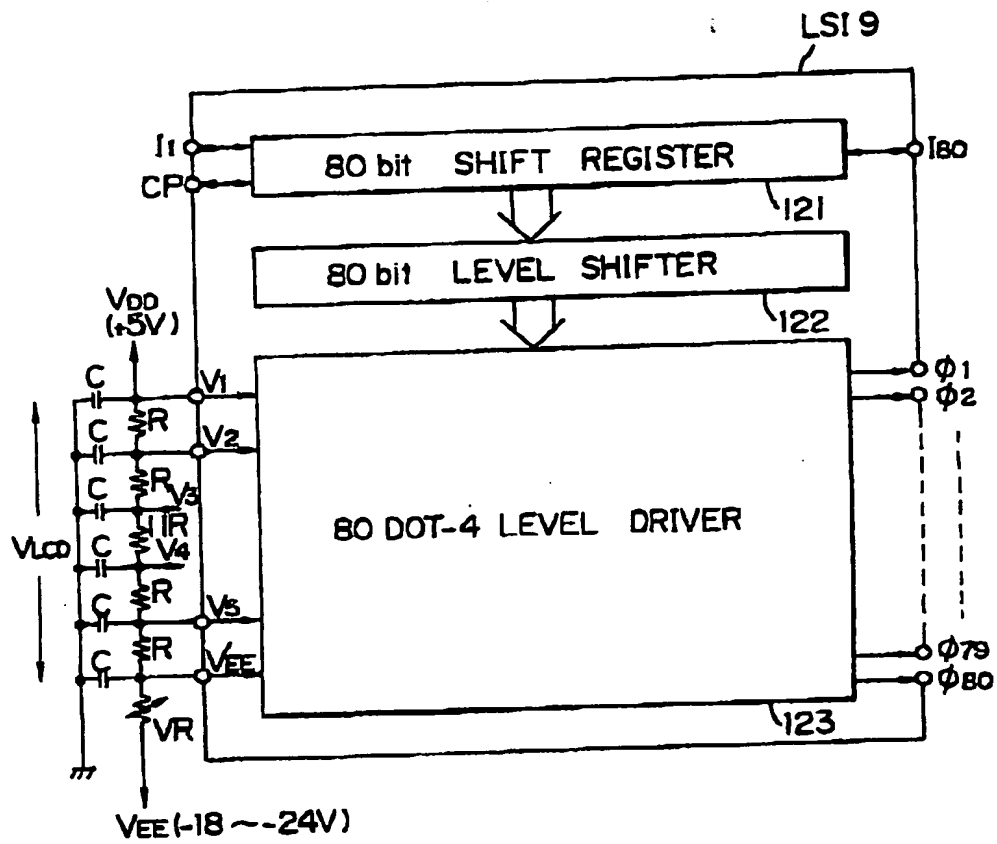
DRIVE  
SIGNAL  $\phi_1$



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Fig. 12



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Fig. 13A CP

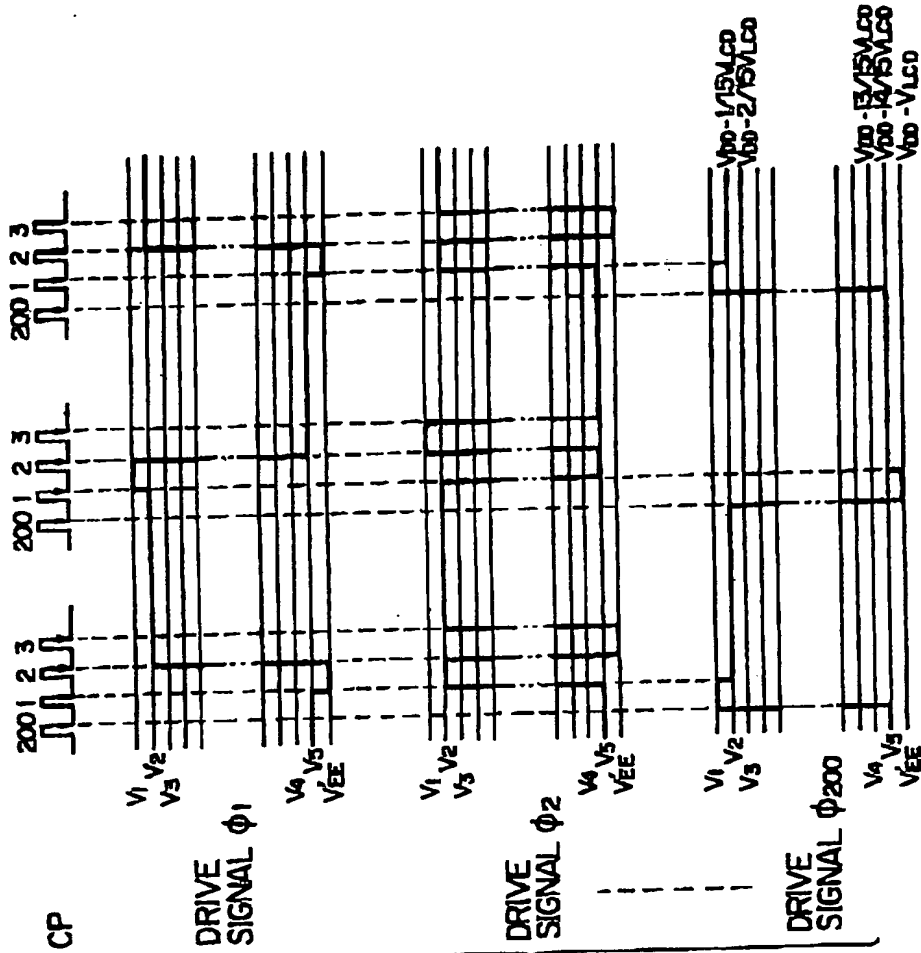
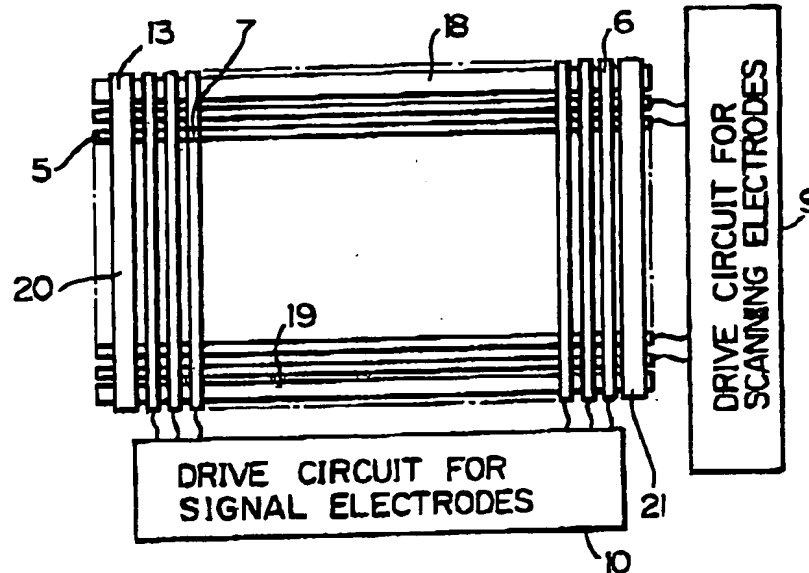


Fig. 13B

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id11

Fig.14



- 1: LIQUID CRYSTAL DISPLAY PANEL
- 2: UPPER GLASS SUBSTRATE
- 3: LOWER GLASS SUBSTRATE
- 4: LIQUID CRYSTAL
- 5: SCANNING ELECTRODES
- 6: SIGNAL ELECTRODES
- 7: DISPLAY PICTURE ELEMENT
- 8: EFFECTIVE DISPLAY RANGE
- 9: DRIVE CIRCUIT FOR SCANNING ELECTRODES
- 10: DRIVE CIRCUIT FOR SIGNAL ELECTRODES
- 11: SUBSTRATE FOR MOUNTING DRIVE CIRCUIT
- 14: OUTSIDE OF EFFECTIVE DISPLAY RANGE
- 18: UPPER ELECTRODE OUTSIDE EFFECTIVE DISPLAY RANGE
- 19: LOWER ELECTRODE OUTSIDE EFFECTIVE DISPLAY RANGE
- 20: LEFT ELECTRODE OUTSIDE EFFECTIVE DISPLAY RANGE
- 21: RIGHT ELECTRODE OUTSIDE EFFECTIVE DISPLAY RANGE

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Fig. 15

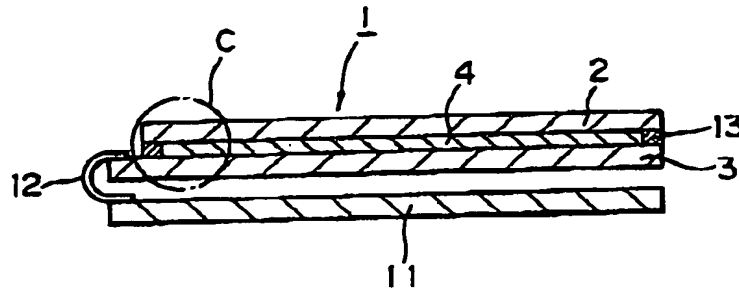
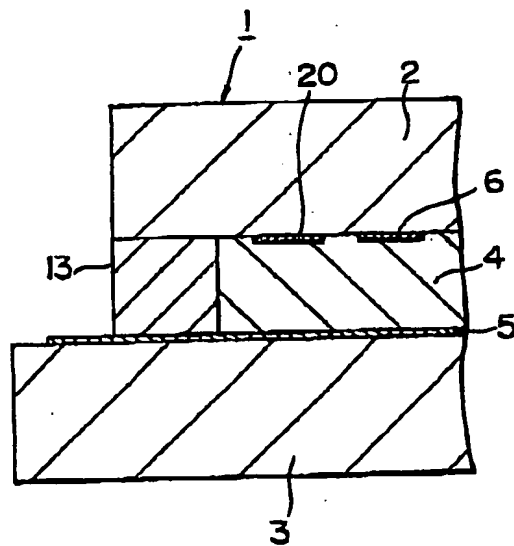


Fig. 16



LIQUID CRYSTAL DISPLAY APPARATUS

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The present invention relates to a dot matrix type liquid crystal display apparatus to be used as a display for such business machines as computers, word processors and the like.

Fig. 1 is a front view of a liquid crystal display panel according to a prior art.

Fig. 2 illustrates dispositions of electrodes for the display panel.

Fig. 3 is a sectional view of the panel shown in Fig. 1. and

Fig. 4 is an enlarged view of the portion A shown in Fig. 3.

In these drawings, numeral 1 designates a liquid crystal display panel. numeral 2 an upper substrate made of glass disposed on the upper surface of the panel. numeral 3 a lower substrate made of glass disposed on the lower surface of the panel. numeral 4 a liquid crystal provided between the opposing glass substrates, numeral 5 scanning electrodes disposed transversely on the lower glass substrate on the side facing the liquid crystal 4. numeral 6 signal electrodes disposed longitudinally on the upper glass substrate 2 on the side facing the liquid crystal 4. numeral 7 picture elements formed at the points where electrodes 5 and 6 cross each other and numeral 8 an effective display range defined by the display picture elements. Numeral 9 designates a drive circuit for the scanning electrodes while

numeral 10 designates a drive circuit for the signal electrodes, both of which are mounted on a substrate 11 on which the drive circuits are mounted. Numeral 12 designates a cable connecting the liquid crystal panel 1 to the drive circuit substrate 11 and numeral 13 designates a sealing material.

In the liquid crystal display apparatus according to prior art, the signal electrodes 6 and the scanning electrodes 5 are constituted in a matrix configuration by means of transparent electrode membranes respectively provided on the upper glass substrate 2 and the lower glass substrate 3 of the liquid crystal display panel 1. The points where the scanning electrodes 5 and the signal electrodes 6 cross define the picture elements 7.

In the constitution explained above, when scanning signals are transmitted from the drive circuit 9 for the scanning electrode to the scanning electrodes 5 and the signals are sent to the signal electrodes 6 from the drive circuit 10 for the signal electrodes, the liquid crystal 4 corresponding to the picture elements 7, at the crossing of the electrodes 5 and 6 to which the signals have been transmitted is operative for display. The area where these picture elements 7 are concentrated can provide an effective display range 8. When the liquid crystal panel 1 is operative for display, the color hue of the background beyond the effective display range is different from that of the background in the effective display range 8.

Since the liquid crystal display apparatus according to prior art has the above-explained constituted, when

characters and pictures are composed by using picture  
elements 7 at the extreme end of the effective display range  
8, the color hue of the background of the effective display  
range 8 is different from that of the background around the  
5 effective display range 14 and the quality will therefore be  
poor. It is particularly noticeable that when the color of  
the background around the effective display range 14 is the  
same as the color of the display of characters and pictures,  
it will be difficult to distinguish the characters and  
10 pictures from the background.

The aim of the present invention is to reduce the  
problems mentioned above.

According to the present invention there is provided  
15 a liquid crystal display apparatus having a liquid crystal display panel  
with an effective display range and wherein, when the display panel  
is operative for display, the background around said  
effective display range has substantially the same color  
as the background within the effective display range.

20 The present invention can thus provide

a liquid crystal display apparatus adapted to  
display characters and pictures wherein electrode patterns  
are provided outside the effective display range of a liquid  
crystal display panel in such a manner as to surround the  
25 effective display range, and a drive circuit for the electrode  
patterns is provided to drive the electrode patterns so that  
the color of the background around the effective display  
range may become the same as that of the background in the  
effective display range.



In other words, the present invention allows

the provision of a liquid crystal display apparatus wherein electrode patterns are provided around the effective display range of a liquid crystal display panel in such a manner as to surround the effective display range and a drive circuit exclusively provided for such electrode patterns is disposed separately from the drive circuits provided for the scanning electrodes and the signal electrodes.

10 The present invention can also provide a liquid crystal display apparatus adapted to display characters and pictures wherein electrode patterns corresponding to the scanning electrodes and the signal electrodes are provided around the effective display range of a liquid crystal display panel and a drive circuit for the scanning electrodes and a drive circuit for the signal electrodes are provided to drive the electrode patterns, so that the colour of the background around the effective display range is the same as that of the background in the effective display range when the liquid crystal display panel is operative for display.

20 The present invention can also provide a liquid crystal display apparatus wherein electrode patterns equivalent to the scanning electrodes and the signal electrodes are provided outside the effective display range of the liquid crystal display panel, so that the same voltage as that which is applied when the liquid crystal display panel is operative for display and the picture elements are not displayed on the electrodes can be applied

from the drive circuits for the scanning electrodes and the signal electrodes.

Preferably according to the present invention, the color of the background of the entire surface of the liquid crystal display panel can be the same and thus an excellent display quality can be obtained even if the characters and picture images are constituted by utilizing the picture elements at the extreme outer portion in the effective display range.

Preferably in the liquid crystal display apparatus according to the present invention, electrode patterns that are able to surround the effective display range and the drive circuit provided exclusively for the electrode patterns are provided around the effective display range of the liquid crystal panel and, when the liquid crystal display panel is operative for display, a voltage that will not cause the picture elements to display is applied to the electrode patterns from the exclusive drive circuit so that the color of the background both within and around the effective display range can be made the same, and even if the display picture elements at the extreme outer portion of the effective display range are used to constitute characters and pictures, characters and pictures having an excellent display quality can be obtained.

According to the present invention, since the electrode patterns can be provided around the effective display range of a liquid crystal display panel and a voltage signal can be applied from the exclusive drive circuit to the electrode patterns, a liquid crystal display apparatus can be provided at a reasonable cost that is capable of offering

excellent display quality by virtue of the color of the background around the effective display range of a liquid crystal display panel being the same as that of the background within the effective display range.

5           According to the inventive liquid crystal display apparatus, electrode patterns corresponding to the scanning electrodes and the signal electrodes can be provided around the effective display range of the liquid crystal panel, so that when the liquid crystal display panel is operative for  
10   display, a voltage which is similar to that which is applied to the electrode patterns within the effective display range can also be applied to the electrode patterns outside the effective range from the drive circuits for the scanning electrodes and the signal electrodes, thus generating the  
15   same color background not only within but also outside the effective display range. Consequently, even if the characters and pictures are constituted by utilizing picture elements at the extreme outer portion of the effective display range, such characters and pictures will possess an  
20   excellent display quality.

The drawings and the following description are exemplary only.

Fig. 1 is front view of the liquid crystal display panel of a liquid crystal display apparatus according to a prior art;

25           Fig. 2 illustrates the disposition of the electrodes in the liquid crystal display panel shown in Fig. 1;

Fig. 3 is a sectional view of the liquid crystal display panel shown in Fig. 1:

Fig. 4 is an enlarged view of the portion designated by A in Fig. 3;

Fig. 5 is a front view of the liquid crystal display panel of the liquid crystal display apparatus according to the present invention;

Fig. 6 illustrates the disposition of the electrodes in a liquid crystal display panel according to the first embodiment of the present invention;

Fig. 7 is a sectional view of the liquid crystal display panel shown in Fig. 6;

Fig. 8 is an enlarged view of the portion designated by B in Fig. 7;

Fig. 9 illustrates in detail the drive circuit for the signal electrodes and the drive circuit for the scanning electrodes shown in Fig. 6, both of the drive circuits being connected to the liquid crystal display panel;

Fig. 10 illustrates one of the drive LSI's 1 through 8 in the drive circuit for signal electrodes shown in Fig. 9, such as the drive LSI 1 which is adapted to generate drive signals  $\phi_1 - \phi_{80}$ ;

Fig. 11A through Fig. 11C illustrate signal wave forms to assist in explaining the operation of the drive circuit for the signal electrodes shown in Fig. 10;

Fig. 12 illustrates one of the drives LSI 9 through LSI 11 in the drive circuit 10 for scanning electrodes shown in Fig. 9, for example, the drive LSI 9 adapted to generate drive signals  $\phi_1 - \phi_{80}$ ;

Fig. 13A and Fig. 13B illustrate signal wave forms for the purpose of explaining the operation of the drive circuit for scanning electrodes shown in Fig. 12;

Fig. 14 illustrates the disposition of the electrodes in a liquid crystal display panel according to the second embodiment of the present invention;

Fig. 15 is a sectional view of the liquid crystal display panel shown in Fig. 14; and

Fig. 16 is an enlarged view of the portion designated by C in Fig. 15.

The first embodiment of the present invention will now be explained by referring to the accompanying drawings.

Fig. 5 is a front view of the liquid crystal display panel according to the first embodiment of the present invention. Fig. 6 illustrates the disposition of the electrodes for the liquid crystal display panel. Fig. 7 is a sectional view of the panel shown in Fig. 5. Fig. 8 is an enlarged view of the portion designated by B in Fig. 7.

Throughout the drawings, numerals 1 to 14 designate the same or equivalent portions. Numeral 15 designates electrode patterns defined in the form of a frame around the effective display range 14 of the upper and lower glass substrates 2 and 3. Numeral 16 designates conductor members adapted to connect the electrode patterns 15 of the upper and lower glass substrates 2 and 3. Numeral 17 designates a drive circuit for the electrode patterns around the effective display range 14 and mounted on the substrate 11 together with the drive circuits 9 and 10.

In the liquid crystal display apparatus constituted in the above-described manner, the same voltage as that which is applied to the picture elements 7 when they are not in the display mode is applied to the electrode patterns 15 provided around the effective display range 14 of the liquid crystal display panel 1 from the exclusive drive circuit for the electrode patterns. As a result, the color hue of the background around the effective display range 14 becomes the same as that of the background in the effective display range 8, so the boundary between the effective display range and the portion surrounding it disappears.

If any boundary exists between the effective display range and the portion surrounding it, particularly when the color of the background around the effective display range is the same as that of the picture elements, it will be difficult to distinguish those characters and pictures that are constituted by elements at the extreme outer portion of the effective display range. If there is no such boundary, however, the above-mentioned problems can be eliminated, and the display quality can thus be improved.

It should be understood that while electrode patterns 15 that form a rectangular frame have been described in connection with the above-mentioned embodiment, the electrode patterns 15 may in fact be divided into electrode patterns that are respectively equivalent to the scanning electrodes 5 and the signal electrodes 6. In this case, exclusive drive circuits may be provided for the respective electrodes, so that the same effect as that of the embodiment described above can be attained.

Fig. 9 illustrates in greater detail the drive circuit 9 for the signal electrodes and the drive circuit 10 for the scanning electrodes, both of these drive circuits being connected to the liquid crystal display panel 1. The drive circuits 9 and 10 are respectively comprised of a plurality of LSI's for drive. As can be seen from the drawing, with a liquid crystal display comprising 640 dots by 200 dots, the drive circuit 9 for the signal electrodes is made up of 8 LSI's, LSI1 through LSI8, while the drive circuit 10 for the scanning electrodes is made up of 3 LSI's, LSI9 through LSI11. LSI1 through LSI11 are respectively designed for 80 bits, 1/200 duty and 1/15 bias.

Fig. 10 illustrates one of the drive LSI's 1 through 8 in the drive circuit 9 for the signal electrodes, such as the drive LSI1 which is adapted to generate drive signals  $\phi_1 - \phi_{80}$ . This LSI is comprised of 80 bit shift register 101, 80 bit latch 102, 80 bit level shifter 103 and 80 dot-4 level driver 104. Figs. 11A through 11C illustrate signal wave forms to assist in explaining operation of the drive circuit 9 for the signal electrodes shown in Fig. 10. When the clock pulse CP is input to the 80 bit shift register 101, load pulse signal (Fig. 11A) is input to the 80 bit latch 102 and voltage level signals  $V_1$ ,  $V_3$ ,  $V_4$  and  $V_{EE}$  are applied to the 80 dot-4 level driver 104, then the driver 104 outputs the signal electrode drive signals  $\phi_1 - \phi_{80}$  (Fig. 11C). Fig. 11B illustrates the latch data which is output from the 80 bit latch 102.

Fig. 12 illustrates one of the drive LSI's 9 through 11 in the drive circuit 10 for the scanning electrodes, for

example the drive LSI9 adapted to generate drive signals  $\phi_1$  -  $\phi_{80}$ . This LSI is composed of 80 bit shift register 121, 80 bit level shifter 122 and 80 dot-4 level driver 123. Figs. 13A and 13B illustrate signal wave forms for the

5 purpose of explaining operation of the drive circuit 10 for the scanning electrodes. When the clock pulse CP (Fig. 13A) is input to the 80 bit shift register 121 and voltage level signals  $V_1$ ,  $V_2$ ,  $V_3$  and  $V_{EE}$  are applied to the 80 dot-4 level driver 123, the scanning electrode drive signals  $\phi_1$ ,  $\phi_2$  ...  $\phi_{80}$  (Fig. 13B) are then output from the driver 123.

10 The second embodiment of the present invention will next be explained by referring to the accompanying drawings. Fig. 14 illustrates disposition of the electrodes of the liquid crystal display panel shown in Fig. 5. Fig. 15 is a sectional view of the display panel shown in Fig. 14. Fig. 15 16 is an enlarged view of the portion designated by C in Fig. 15. In these drawings, numerals 1 through 14 show members which are the same or equivalent to those illustrated in Figs. 1 through 4. Numeral 18 designates an upper electrode which is outside the effective display range. Numeral 19 designates a lower electrode which is outside the effective display range. These electrodes are provided in the same manner as the scanning electrodes 5 which are outside the effective display range and are driven by the drive circuit 9 for the scanning electrodes. Numeral 25 20 designates a leftside electrode which is outside the effective display range and numeral 21 designates a right side electrode, also outside the effective display range, these electrodes being provided outside the effective



display range to the left and right in the same manner as the signal electrodes 6 and being adapted to be driven by the drive circuit 10 for the signal electrodes.

In the liquid crystal display apparatus constituted as above, the upper electrodes 18 and the lower electrodes 19, both of which are outside the effective display range and which are equivalent in function to the scanning electrodes 5, as well as the left electrode 20 and the right electrode 21 which are also outside the effective display range and are equivalent in function to the signal electrodes 6, are provided outside the effective display range 14 in such a manner as to surround the effective display range 8. Thus, when the liquid crystal display panel 1 is operative for display, the same voltage as that which is applied to the display picture elements 7 inside the effective display range 8 when they are not in the display mode is applied to these electrodes 18 to 21 from the drive circuit 9 for the scanning electrodes and the drive circuit 10 for the signal electrodes, so that the color of the background 14 around the effective display range can be made the same as that of the back ground 8 within the effective display range, so that no boundary appears between the effective display range and the portion around it. In this way, if the picture elements 7 at the extreme outer portion of the effective display range 8 are used for constituting characters and pictures, the display quality of these characters and pictures can be improved.

It is to be noted that, while in the above-explained embodiment each one of the upper electrode (18), the lower

electrode (19), the left electrode (20) and the right electrode (21) are provided outside the effective display range (14), a similar effect may be attained if a plurality of such electrodes are disposed at the respective locations.

5       The drive circuits for the upper and lower electrodes 18, 19 and the left and right electrodes 20, 21 which are outside the effective display range are provided in a number corresponding to that of the patterns of the scanning and signal electrodes and are comprised of drive LSI's which are  
10       respectively the same as the LSI's shown in Fig. 10 and Fig. 12. These drive LSI's are adapted to be energized when the liquid crystal display panel is operative for display. A voltage at the same level as that which is available when  
15       there are no display data is applied from the respective drive LSI's for the left and right electrodes 20, 21 for the signal electrodes to the corresponding electrodes.

**Claims:**

1. A liquid crystal display apparatus comprising a liquid crystal display panel having signal electrode means and scanning electrode means which are arranged in a matrix configuration, the signal and scanning electrode means being comprised of transparent electrode membranes between an upper glass substrate and a lower glass substrate, a first drive circuit means adapted to drive said signal electrode means and a second drive circuit means adapted to drive said scanning electrode means, wherein when said signal electrode means and said scanning electrode means are driven, characters or pictures are displayed on said liquid crystal display panel, said liquid crystal display apparatus being characterized by;

electrode pattern means provided around the effective display range of said liquid crystal display panel, and

drive means adapted to drive said electrode pattern means so that when said liquid crystal display panel is operative for display, the color hue of the background around said effective display range becomes the same as that of the background within said effective display range.

2. A liquid crystal display apparatus as claimed in claim 1 further characterized in that said electrode pattern means is divided into a first and a second electrode pattern means equivalent respectively to said signal electrode means and said scanning electrode means.

3. A liquid crystal display apparatus as claimed in claim 2 further characterized in that said drive means is comprised of a first electrode pattern drive circuit adapted

to drive said first electrode pattern means and a second electrode pattern drive circuit adapted to drive said second electrode pattern means.

4. A liquid crystal display apparatus as claimed in Claim 1 further characterized in that said electrode pattern means is divided into a first and a second electrode pattern means respectively equivalent to said signal electrode means and said scanning electrode means. said drive means is comprised of a first electrode pattern drive circuit adapted to drive said first electrode pattern means and a second electrode pattern drive circuit adapted to drive said second electrode pattern means, and said first drive circuit means includes said first electrode pattern drive circuit and said second drive circuit means includes said second electrode pattern drive circuit.

5. A liquid crystal display apparatus having a liquid crystal display panel with an effective display range and wherein, when the display panel is operative for display, the background around said effective display range has substantially the same color as the background within the effective display range.

6. A display apparatus according to claim 5 wherein a separate drive circuit is provided for electrodes associated with the background around the effective display range.

7. A liquid crystal display apparatus constructed and arranged substantially as hereinbefore described with reference to and as illustrated in Figures 5 to 16 of the accompanying drawings.